**EE5110/EE6110 Selected Topics on Automation and Control**

Segment A: Semiconductor Manufacturing

Description:
Temperature control is critical in the processing of semiconductor wafers in various thermal processing steps such as RTP and Bake/Chill. In this assignment, our objective is to design a temperature controller for the baking operation in lithography. Your target is to minimize the temperature uniformity across the wafer during the entire bake operation. The wafer is assumed to be of 300mm in diameter. The design specification for our heating process should have the following characteristics:
1. A bake operation of about 180 seconds.
2. The wafer steady-state temperature should be $110^0$C.
3. The overshoot on the wafer temperature should not be more than $5^0$C
4. The temperature non-uniformity during the bake process should be minimized.

Detailed description of the programmable multi-zone thermal processing system can be found in [1]. The simplified state-space model is given in the Matlab file, ibc_modelt23.m. The output of the Matlab file gives the time and temperature of the bake-plate and wafer, you can use it together with an ode solver or extract out the state-space matrices. For this project, you can discretize your bake-plate to $N$=3 zones, i.e. you should simulate for 3 zones. In addition, note that feedback to your controller is the bake-plate temperature, not the wafer temperature since there are no sensors on the wafer although the model will give you both the wafer and bake-plate temperatures.

For your plots, you should show the following:

1. Bake-plate and wafer temperatures across the $N$ zones during the entire bake operation (similar to the top and middle plots in slide 99).
2. Temperature non-uniformity across the wafer during the bake operation (similar to bottom plot in slide 99).
3. Input signal into the bake-plate at the $N$ zones during the bake operation.

All simulation results, discussions, and observations should be documented in a full technical report with MATLAB source codes during submission.

Please put your report and Matlab code together in a zip file. Name the file A1234567.zip (where A1234567 is your matric number) and upload to our Segment A submission folder.

Due Date: 11 September 2023, 12 noon

References:
[1] Tay, A., WK Ho, N Hu, XQ Chen, "Estimation of wafer warpage profile during thermal processing in microlithography", Review of Scientific Instruments, 76, 075111 (2005)

[2] Tay, A., HT Chua, YH Wang, G Yang, WK Ho, "Modeling and Real-Time Control of Multizone Thermal Processing System for Photoresist Processing", Industrial & Engineering Chemistry Research, 52, 4805–4814 (2013)

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